

REMARKS

Withdrawn Claims

Claims 174, 178 and 179 have been withdrawn as being "independent or distinct from the invention originally claimed". The Office Action further states that these claims "are directed to a different embodiment". Applicant requests reconsideration of this withdrawal as provided in 37 CFR 1.145, as all of the withdrawn claims are in the elected embodiment.

The Office Action mailed 01/27/2005 included four embodiments (Embodiments I-IV). By the Amendment dated 02/04/2005 Embodiment I was elected. Embodiment I was defined as: Embodiment I (Claims 153-179), directed to a semiconductor component, a thinned semiconductor die, a first polymer layer and a second polymer layer.

Each withdrawn claim (174, 178, 179) is in the elected Embodiment I, as it is defined in the Office Action mailed 01/27/2005. In particular, all of the limitations in the withdrawn claims further define features of Embodiment I.

Claim 174 recites "the first polymer layer and the second polymer layer have beveled edges". Embodiment I is defined as including "first and second polymer layers". Claim 174 thus reads on the Embodiment I.

Claim 178 recites "the die contacts comprise bond pads". Embodiment I is defined as including claim 174 which recites die contacts. Claim 178 thus reads on Embodiment I. In addition, claim 178 has been rejected under 35 USC §103, such that it's withdrawal is inconsistent with the rejections.

Claim 179 recites "the die contacts comprise redistribution pads". Embodiment I is defined as including claim 174 which recites die contacts. Claim 179 thus reads on Embodiment I.

Rejections Under 35 USC §103(a)

Claims 170, 172, 173, 175-177, 264 and 270 have been rejected under 35 USC 103(a) as being obvious over Brooks (US Patent No. 5,496,775) in view of Farnworth et al. (US Patent No. 6,620,731) and "Moisture Absorption In No-Flow Underfill Materials

And Its Effect On Interfacial Adhesion To Solder Mask Coated FR4 Printed Wiring Board" by Ferguson et al.

Claims 178, 262 and 265-267 have been rejected under 35 USC 103(a) as being obvious over Brooks (US Patent No. 5,496,775) in view of Farnworth et al. (US Patent No. 6,620,731) and "Moisture Absorption In No-Flow Underfill Materials And Its Effect On Interfacial Adhesion To Solder Mask Coated FR4 Printed Wiring Board" by Ferguson et al. and Kinsman et al. (US Patent No. 6,717,245).

Claims 171 and 268 have been rejected under 35 USC 103(a) as being obvious over Brooks (US Patent No. 5,496,775) in view of Farnworth et al. (US Patent No. 6,620,731) and "Moisture Absorption In No-Flow Underfill Materials And Its Effect On Interfacial Adhesion To Solder Mask Coated FR4 Printed Wiring Board" by Ferguson et al. and Beffa et al. (US Patent No. 6,233,185).

Claim 269 has been rejected under 35 USC 103(a) as being obvious over Brooks (US Patent No. 5,496,775) in view of Farnworth et al. (US Patent No. 6,620,731) and "Moisture Absorption In No-Flow Underfill Materials And Its Effect On Interfacial Adhesion To Solder Mask Coated FR4 Printed Wiring Board by Ferguson et al. and Lin (US Patent No. 5,436,203).

Claim 271 has been rejected under 35 USC 103(a) as being obvious over Brooks (US Patent No. 5,496,775) in view of Farnworth et al. (US Patent No. 6,620,731) and "Moisture Absorption In No-Flow Underfill Materials And Its Effect On Interfacial Adhesion To Solder Mask Coated FR4 Printed Wiring Board by Ferguson et al. and "Functional And Smart Materials" by Wang.

The rejections under 35 USC §103 are traversed for the reasons to follow.

Summary Of Claimed Subject Matter

Claims 170-179 and 262-271 are directed to a semiconductor component 16 (Figures 4A-4C and 1K) which includes a thinned semiconductor die 10T (Figure 4C) having a circuit side 20 (Figure 4C), a thinned back side 22T (Figure 4C), and a plurality of peripheral edges 30 (Figure 4C). The component 16 (Figures 4A-4C) also includes a first polymer layer (circuit side polymer layer 36P (Figure 4C) and edge polymer layers 40 (Figure 4C) covering the circuit side 20 and the edges 30. The component 16 (Figures

4A-4C) also includes a second polymer layer (back side polymer layer 38P (Figure 4C)) covering the back side 22T.

The component 16 (Figures 4A-4C) also includes a plurality of die contacts 18 (Figure 4C) on the die 10T, and a plurality of contact bumps 24P (Figure 4B) on the die contacts 18 embedded in the first polymer layer 36P (Figure 4C). The component 16 (Figures 4A-4C) can also include terminal contacts 42 (Figure 4C) on the contact bumps 24P. As shown in Figure 8F, the component can also include conductive vias 70A (Figure 8F) in electrical communication with the die contacts 18, and terminal contacts 42A (Figure 8F) on the conductive vias 70A.

35 USC §103(a) Rejections Of Claims 170, 172, 173, 175-177, 264 and 270 Over Brooks, and Farnworth et al. ('731) And Ferguson et al.

The 35 USC §103(a) rejections of claims 170, 172, 173, 175-177, 264 and 270 over Brooks, Farnworth et al., and Ferguson et al. are traversed, as the rejected claims include limitations that are not disclosed or suggested by the prior art. These limitations taken with the claims "as a whole" make the claims unobvious over the art. The rejections are further traversed as one skilled in the art at the time of the invention would have no reason to combine the references in the manner of the Office Action.

Cited Art

Brooks was cited as disclosing a semiconductor device having a die 30 with die contacts, a plurality of contact bumps 32 on the die contacts, a first polymer layer 36B covering the circuit side and edges of the die 30, and a second polymer layer 36A covering the backside of the die.

Farnworth et al. was cited as disclosing a semiconductor device with a thinned die 10.

Ferguson et al. was cited as disclosing a polymer material comprising a self planarizing thermoset underfill film which is rigidifying.

1. Undisclosed Limitations In Independent Claim 170

Independent claim 170 recites "a first polymer layer comprising a self planarizing thermoset underfill film covering the circuit side and the peripheral edges". In Brooks the first polymer layer 36B does not cover the edges of the die 30, such that a seam is formed on the edges. The seam compromises encapsulation and the rigidity of the edges of the die 30.

Further, an underfill material has not heretofore been used to encapsulate and seal the edges of a thinned semiconductor die. This material provide new and unexpected results including: improved encapsulation, improved rigidity, and improved fabrication.

Admittedly thermoset underfill materials are known in the art. However, underfill materials are conventionally used to fill the space between a semiconductor chip (or package) and a substrate, such as a printed circuit board. Ferguson et al. discloses this conventional use of an underfill polymer (first sentence of Abstract and Figure 1). There is no suggestion in the cited art of employing an underfill material to encapsulate and rigidify the face and edges of a thinned semiconductor die to form a singulated semiconductor component. Further, it would not be obvious to use an underfill material for encapsulating the face and edges of a singulated die as it has not previously been utilized for this application.

In addition to not disclosing the claimed structure, the cited prior art does not disclose an "underfill film" used to seal and encapsulate a thinned die. Rather, Ferguson et al. discloses a "deposited" underfill material (page 328, first column, last paragraph) between a chip and substrate. The presently claimed component includes an "underfill film" on the circuit side and edges of a thinned die which is not a deposited material, but rather a piece of material placed on the wafer during the fabrication process (paragraph [0178]). The film facilitates the fabrication process because a deposition step is not required.

The Office Action further states: "Ferguson et al. ("Ferguson") discloses a semiconductor device where the polymer material comprising a self planarizing thermomset underfill film which is rigidifying (For Example: See Page 327)". However, the cited passage doesn't suggest using a thermoset underfill material to rigidify the edges of a thinned die. Rather, the cited passage states: "Thermoset polymers

(such as epoxies), which are composed of a rigid, three-dimensional cross-linked network between polymer chains, are more resistant to moisture penetration and swell rather than dissolve in the presence of moisture." An underfill material with a rigid molecular structure is not the same as an underfill layer rigidifying the edges of a thinned die. The teachings of Ferguson et al., rather than being assessed from the viewpoint of one skilled in the art, have been slanted to support the rejections.

The Office Action further characterizes the "self planarizing thermoset" and "rigidifying" limitations in claim 170 as being "product by process" limitations. However, this analysis is incorrect. The "planarizing" limitation was discussed in the Amendment dated 09/11/2006 as being a structural limitation under the criteria of MPEP §2113. These arguments are incorporated by reference into the present Amendment.

It is also well known in the art that "thermoset" materials have unique physical characteristics. For example, the Cambridge Dictionary of Science and Technology defines "thermosetting compositions" as:

"Compositions in which a chemical reaction takes place while the resins are being moulded under heat and pressure, the appearance and chemical and physical properties are completely changed, the product is resistant to further application of heat".

Similarly, the term "rigidifying" is not associated with any process but rather is a functional limitation. Claims are to be evaluated "as a whole", and all claim limitations considered especially when missing from the art. In re Gulack, 703 F.2d 1381, 217 USPQ 401 (Fed. Cir. 1983). It is submitted that an underfill film which rigidifies the edges of a thinned die is missing from the art.

2. No Reason To Combine References

Under the criteria established by KSR Int'l Co., v. Teleflex, Inc., No 04-1350 (U.S. Apr. 30, 2007), in formulating rejections under 35 USC §103(a) it remains necessary to identify a reason why a person of ordinary skill in the art would have combined references.

The Office Action states the proposed reason for combining the thinned die of Farnworth et al. with the device of Brooks as it "aids in exposing conductive members". However, in Farnworth et al. the conductive members 34 are conductive vias. There are

no conductive vias in Brooks, such that the proposed reason for the combination makes no sense.

The Office Action states the proposed reason for using the underfill material of Ferguson et al. in the device of Brooks as "it aids in providing resistance to moisture". However, Ferguson et al. merely states a characteristic of thermoset polymers (such as epoxies) is that they are more resistant to moisture penetration than thermoplastic polymers (page 327, last paragraph). Ferguson et al. doesn't say that underfill materials are more resistant to moisture as implied by the Office Action. Further, Brooks already uses thermoset materials (epoxy) for encapsulation (column 3, line 29), such that the proposed reason for the combination makes no sense.

In addition, Ferguson et al. teaches moisture resistance in the context of "the role moisture plays in package interfacial adhesion" (abstract). Interfacial adhesion is a consideration with a conventional underfill layer between a chip and a substrate. However, in the present component the underfill film is not used as an adhesion layer between a chip and a substrate. One skilled in the art at the time of the invention would thus not view Ferguson et al. as suggesting an underfill material to encapsulate a thinned die.

The rejected dependent claims are submitted to be unobvious over the art for the same reasons as independent claim 170. In addition, these dependent claims include additional limitations which further distinguish the claimed component from the prior art.

Dependent Claim 172

Dependent claim 172 recites "the underfill film cures and planarizes at a temperature of about 200-250 °C, has a Young's modulus of about 4G Pascal, and a coefficient of thermal expansion (CTE) of about 33 parts per million per °C." As stated at paragraph [0174] of the present specification, these are specific characteristics of the underfill material. The Office Action characterizes these limitations as being "product by process". However, this is incorrect as the limitations define physical characteristics of the underfill film.

Dependent Claim 173

Dependent claim 172 recites "the second polymer layer comprises the underfill film". The component is thus encapsulated on six sides by the underfill film. The Office Action states: "It would have been obvious to one having ordinary skill in the art at the time of the invention to modify the semiconductor of Brooks to include polymer material comprising underfill film as disclosed by Ferguson because it aids in providing resistance to moisture (For Example: See Page 327)."

However, Ferguson et al. doesn't teach that underfill films aid in providing resistance to moisture, but rather teaches thermoset polymers are superior to thermoplastic polymers for moisture resistance. Further, Brooks already employs thermoset polymers (epoxy), such that proposed reason for the combination makes no sense.

Dependent Claim 175

Dependent claim 175 recites "a plurality of terminal contacts on the contact bumps". The Office Action states that Figure 4 of Brooks discloses this feature. However, Brooks discloses "gold ball towers" which is not the same as terminal contacts on contact bumps.

Dependent Claim 176

Dependent claim 176 recites "the first polymer layer has a thickness which is less than a height of the contact bumps and each contact bump is surrounded by a portion of the first polymer layer". The Office Action states that Figure 4 of Brooks discloses this feature. However, Brooks discloses "gold ball towers" which is not the same as contact bumps surrounded by a portion of a polymer layer.

Dependent Claim 177

Dependent claim 177 recites "the die includes conductive vias in electrical communication with the die contacts and the contact bumps". The Office Actions states that Farnworth et al. discloses conductive vias. The Office Action further states it would be obvious to modify the semiconductor of Brooks to include conductive vias "because it

aids in providing electrical communication between the integrated circuits and the contacts (For Example: See Abstract)". However, the gold towers (contacts) in Brooks are already in electrical communication with integrated circuits because they are formed on the device bond pads (column 2, line 39).

Dependent Claim 264

Dependent claim 264 recites "a plurality of terminal contacts comprising ball bonds on the contact bumps". The Office Action states that Figure 4 of Brooks discloses this feature. However, the gold ball towers 32 in Brooks are not ball bonds on contact bumps, but rather are welded beads or balls (column 2, lines 41-42).

35 USC §103(a) Rejections Of Claims 178, 262 and 265-267 Over Brooks, Farnworth et al. Ferguson et al. and Kinsman et al.

The 35 USC §103(a) rejections of claims 178, 262 and 265-267 over Brooks, Farnworth et al., Ferguson et al. and Kinsman et al. are traversed for essentially the same reasons discussed above with respect to independent claim 170.

Kinsman et al. was cited as disclosing bond pads (claim 178), solderable metal (claim 262), polymer filled trenches (claim 265), planar surface (claim 266) and polymer layers with different thicknesses (claim 267).

However, these rejections are further traversed as one skilled in the art would have no reason to combine Kinsman et al. with Brooks.

With regard to claims 178 (bond pads) and 262 (solderable metal) the Office Action states the proposed reason as "it aids in providing a connection among the components (For Example: See Figure 2)". This statement is unclear as there is only one component in Figure 2 of Kinsman et al.

35 USC §103(a) Rejections Of Claims 171 and 268 Over Brooks, Farnworth et al., Ferguson et al. And Beffa et al.

The 35 USC §103(a) rejections of claims 171 and 268 over Brooks, Farnworth et al., Ferguson et al. and Beffa et al. are traversed for essentially the same reasons discussed above with respect to independent claim 170.

Claims 171 and 268 recite that the thinned die comprises "a tested and burned in die". Beffa et al. was cited as disclosing a tested and burned in die.

Admittedly tested and burned in dice are known in the art. However, in the present component the tested and burned in die comprises a thinned die encapsulated in a thermoset underfill film.

35 USC §103(a) Rejections Of Claim 269 Over Brooks, Farnworth et al., Ferguson et al. And Lin

The 35 USC §103(a) rejections of claim 269 over Brooks, Farnworth et al., Ferguson et al. and Lin is traversed for essentially the same reasons discussed above with respect to independent claim 170.

Claim 269 recites "the die is contained on a semiconductor wafer having a polymer support dam proximate to edges thereof". Lin was cited as disclosing a polymer support dam.

Although Lin discloses dams 40, 44 on a semiconductor device 30, they do not have the same configuration as the presently claimed polymer dam, and cannot perform the same function. In this regard, the dams 40, 44 on Lin are not on a semiconductor wafer, but are on an epoxy-glass substrate 12 (column 3, lines 9-12). This type of substrate doesn't need a support dam because it includes glass fiber reinforcing material.

In addition, although the polymer dam 44 in Lin is shown in Figure 4 as being proximate to the edges of the substrate 12, there is no disclosure or suggestion of locating the polymer dam proximate to the peripheral edges of a wafer. In this regard, the substrate 12 includes a singulated die 32 so that the dams 40, 44 are near the peripheral edges of the die 32, which is much smaller than a semiconductor wafer.

35 USC §103(a) Rejections Of Claim 271 Over Brooks, Farnworth et al., Ferguson et al. And Wang

The 35 USC §103(a) rejections of claim 271 over Brooks, Farnworth et al., Ferguson et al. and Wang is traversed for essentially the same reasons discussed above with respect to independent claim 170.

Claim 271 recites "the second polymer layer comprises parylene". Wang was cited as disclosing "a semiconductor device that has parylene".

However, Wang teaches a parylene layer which comprises a dielectric layer. A dielectric layer is an interlevel layer, rather than an outer sealing layer as in the present component.

Conclusion

In view of the arguments, favorable consideration and allowance of claims 170-179 and 262-271 is respectfully requested.

The "Cross Reference To Related Applications" has also been updated, and an informality has been corrected on page 23. In addition, an Information Disclosure Statement is being filed concurrently with this Amendment. Should any issues arise that will advance this case to allowance, the Examiner is asked to contact the undersigned by telephone.

DATED this 18th day of July, 2007.

Respectfully submitted:

/Stephen A. Gratton/

Stephen A. Gratton
Registration No. 28,418
Attorney for Applicant

2764 S. Braun Way
Lakewood, CO 80228
Telephone: (303) 989-6353
FAX (303) 989-6538